



Situation Awareness in Network Based Command & Control Systems



Dr. Håkan Warston
euCognition Meeting
Munich, January 12, 2007



Saab Microwave Systems

Products and areas of technology

- Radar systems technology
- Microwave and antenna technology
- Real-time signal processing systems
- Embedded computer systems
- Real-time command, control and communication systems



There is a worldwide Revolution in Military Affairs going on ...

By exploiting the advances in the Information Technology and Mobile Communications Technology a new generation of systems for

Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaisance (C4ISR)

are being developed.

The aim is to **increase operational effectiveness** through greater flexibility in command and control and distributed cooperation in a multi-functional and multinational setting.

There is a need for development of

- new information fusion technology
- new operational methods
- new ways to manage your resources



The characteristics of the next generation C4ISR-systems

- Network based distributed systems
- Users distributed both in "space" and in organisation.
- Designed for joint efforts between multiple organisations
- Interoperability, very important!
- Multi sensor surveillance and multi source real time information systems
- Heterogenous information content

Note, this is not only a development in the military domain! Conflict and crisis management as well as crime fighting demands interagency cooperation. No more stovepipe solutions!



A "dear child" has many names...

- Network Centric Warfare (NCW)
- Network Based Defense (NBD)
- Network Enabled Capabilities (NEC)

When designing the next generation C4ISR systems there are risks to be considered...

The human decision makers will depend on assistance from artificial cognitive systems functions within the C4ISR-system for

- finding relevant information
- combining and processing information
- making predictions
- comprehensible presentation of situation information

"We are drowning in information but starved for knowledge. This level of information is clearly impossible to be handled by present means. Uncontrolled and unorganized information is no longer a resource in an information society, instead it becomes the enemy. -John Naisbitt, Megatrends"

What do we mean by **Situation Awareness**?

*“Situation awareness is the **perception** of the elements in the environment within a volume of time and space, the **comprehension** of their meaning, and the **projection** of their status in the near future.” (Endsley, 1995)*

Creating situation awareness is a challenge to the human decision maker because of

- information overload
- uncertain information
- incomplete information

Creating situation awareness is a challenge to the artificial cognitive system because it involves interpretation of information

Creating a **Common Situation Awareness** between cooperating humans and/or cooperating artificial systems is an even greater challenge because you need create a common interpretation of the information

SENSOR-CONTROL
Mapmenu Picture

ERICSSON

CHANGE ROUTE

Change route

- JAS39 GMTI5
- JAS39 GMTI4
- ERIEYE GMTI2
- UAV GMTI6
- CARABAS3
- UAV GMTI8
- UAV GMTI7

View coverage

- JAS39 GMTI5
- JAS39 GMTI4
- ERIEYE GMTI2
- AEROSTAT GMTI1
- UAV GMTI6
- CARABAS3
- UAV GMTI8
- UAV GMTI7

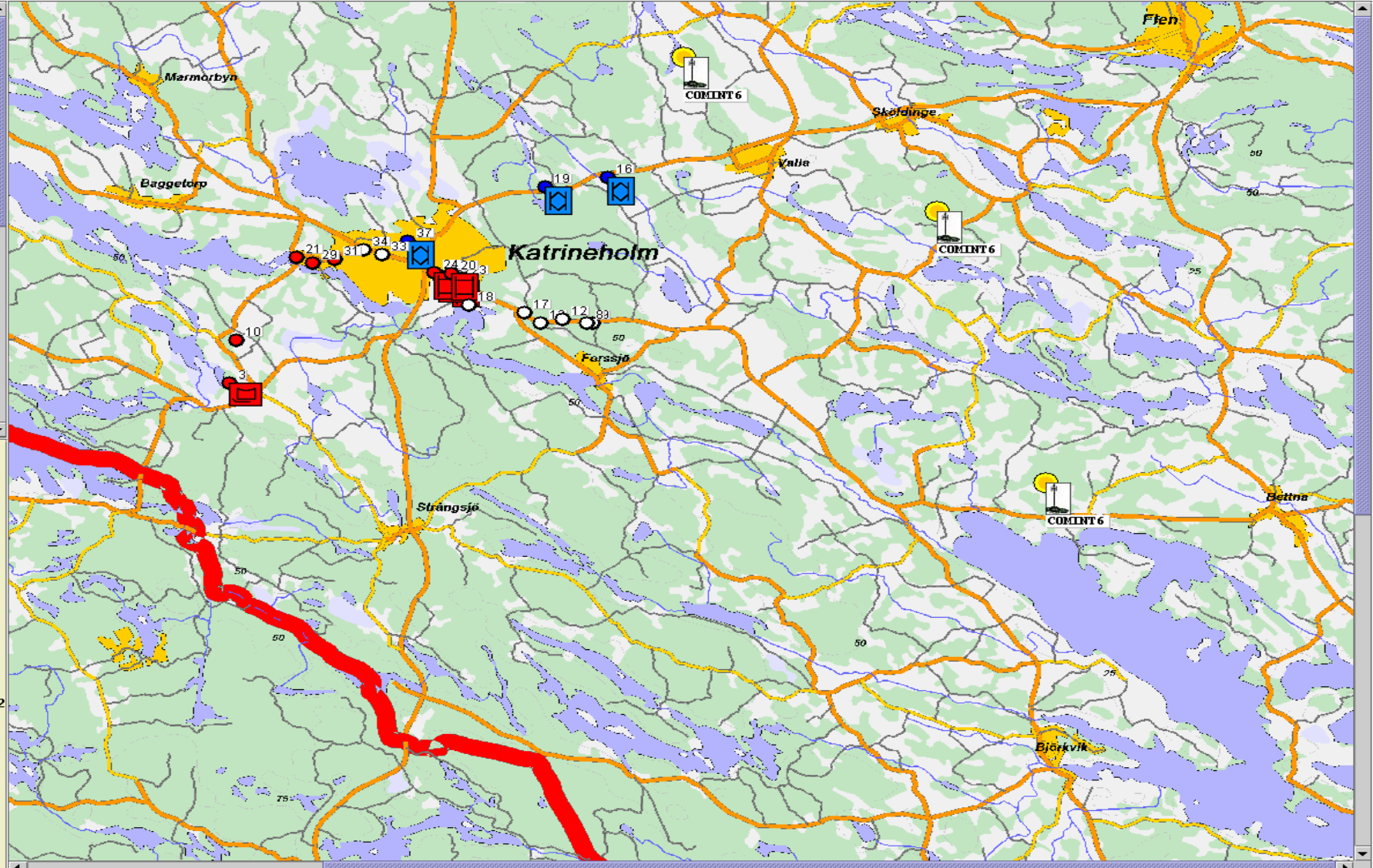
Start [Taskbar icons] 12:58

Recognize targets

- 10
- 16
- 15
- 11
- 13
- 12
- 18
- 17
- 14
- 3
- 1
- 6
- 4
- 2
- 19
- 8

Network nodes

- Fusionnode
- GMTI 1
- UAV GMTI3
- Jas GMTI 4
- Erieye GMTI 2
- Jas GMTI 5
- COMINT6



Data and information fusion

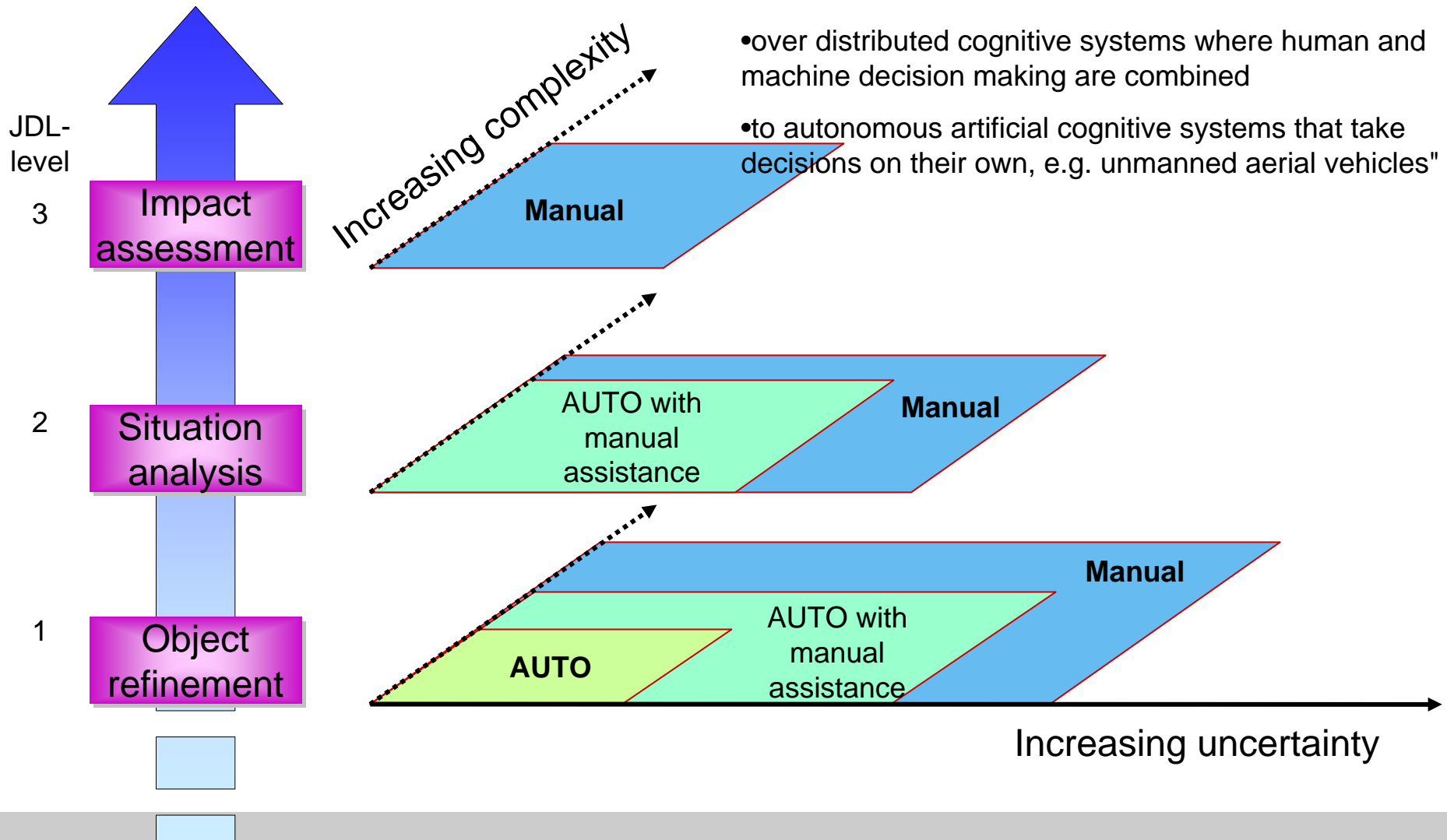
- Data and information fusion has been identified as a core technology underlying decision support systems for situations with large amounts of real-time information.
- Is used to combine data from multiple sensors and related information in order to make inferences that may not be possible by using a single, independent sensor.
- Is the process of combining data or information to estimate or predict entity states.

Using artificial cognitive systems for the processing of situation information the technical system can

- speed up the decision making process,
- support the operator and provide him/her with relevant and refined information during the decision making process

Information processing

- Present situation



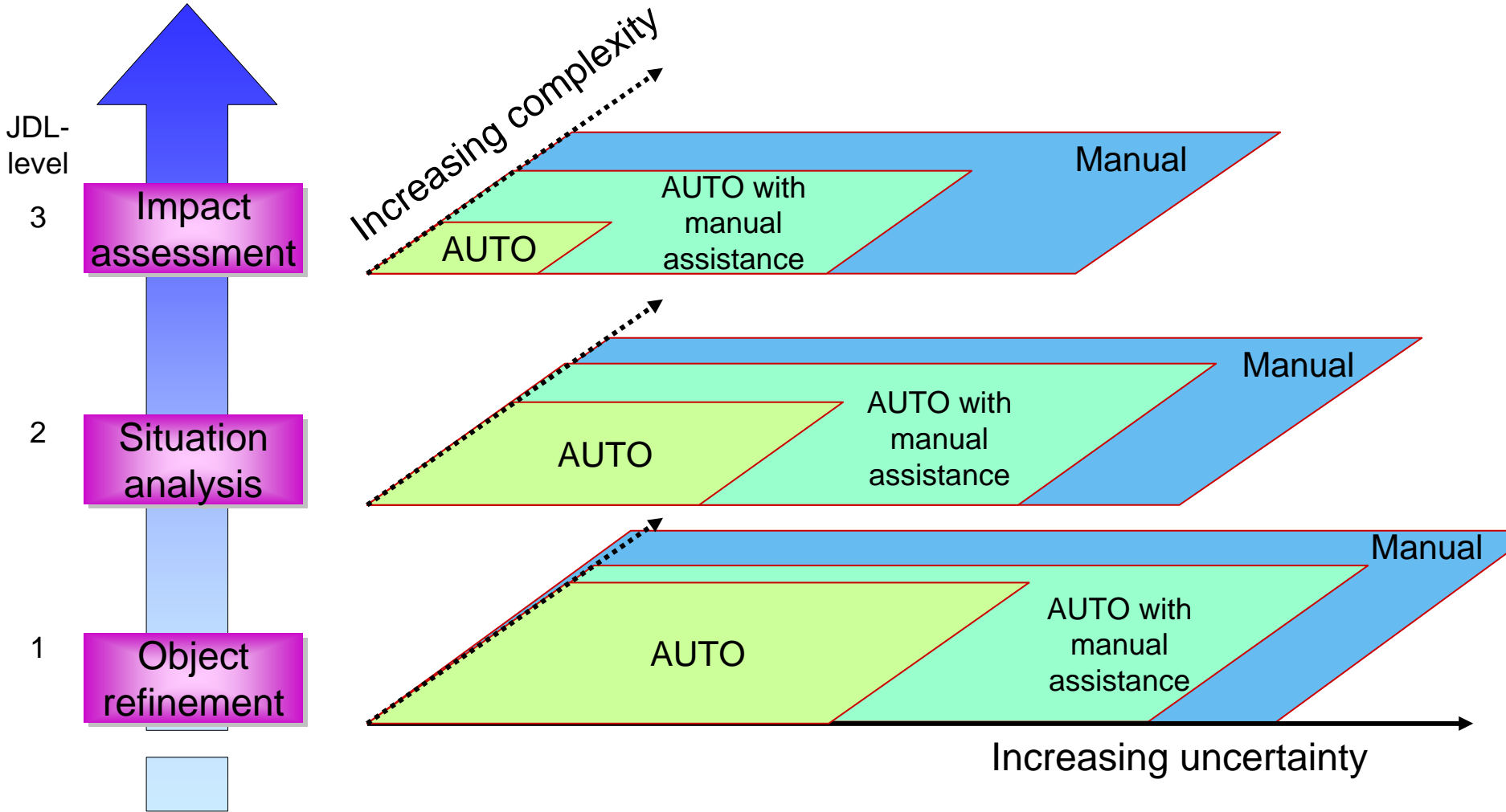
For a wide spectrum of decision making

- from computer systems that only provide input to human decision makers
- over distributed cognitive systems where human and machine decision making are combined
- to autonomous artificial cognitive systems that take decisions on their own, e.g. unmanned aerial vehicles"



Information processing

- Vision ~ 2015-2020



Landmark applications (1)

Situation Assessment

Deals mainly with finding, combining, interpreting, storing, and retaining information for tactical and strategical analysis.

Final result: Conclusions/Estimations about the entities states within the area of interest

Development of methods for finding relations amongst available pieces of information:

objects – environment – context (background information such as, doctrines, plans, ORBAT, ...)

- Estimation of relationships between pieces of information
- Integration of multiple pieces of information and determination of their relevance to goals.

Example of relationships are: Spatio-temporal, Organizational, Causal, Part/Whole, etc ...

(ORBAT=order of battle. Contains mainly organizational information for analysing units. Includes info about composition, disposition, strengths, training, logistics, etc)

Landmark applications (2)

Anomaly detection in surveillance data

- An anomaly is something which deviates from the standard or expected. It is an irregularity which may be difficult to explain using existing rules or theory.
- Anomaly detection approaches build models of normal data and then attempts to detect deviations from the normal model in observed data.

Landmark application (3)

Impact assessment / Threat analysis

Impact assessment: Estimation and prediction of effects on situations of planned or predicted actions by the participants.

This means making inferences about:

- Potential threats
- Enemy capabilities
- Critical vulnerabilities
- Probable courses of action

Reasoning in the presence of uncertainty

- When making inferences we must be able to handle the uncertain nature of conflict and crisis situations.
- Probability theory is a well-understood method of making (uncertain) inferences from uncertain knowledge.

Examples of relevant problems are:

Hypothesis generation, construction and adaptation of the hypotheses in real-time.
Graphical models combining probability theory with graph theory.

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